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[Claim(s)]

[Claim 1]Reduction projection is carried out through a lens at a machining object, covering with a mask which has a mask pattern of specified shape, after decreasing an excimer laser beam emitted from an excimer laser oscillator to a predetermined amount of energy by an attenuator, In an excimer-laser-processing device which performs removal processing of mask pattern shape and an analogue, [a size of said mask pattern, a focal length of a lens, pattern reduction percentage, or a machining object] [parameters /, such as a size etc. of a pattern by which reduction projection was carried out, / which had been decided beforehand] An excimer-laser-processing device irradiating a machining object with an excimer laser beam of the optimal amount of energy for processing by defining a relative position of a mask, a lens, and a machining object automatically, and controlling said attenuator according to said relative position.

[Claim 2]Have the following and said control means A size of said mask pattern, a focal length of a lens, While obtaining parameters decided beforehand, such as a size etc. of a mask pattern by which reduction projection was carried out, to reduction percentage or a machining object of a mask pattern to need, The excimer-laser-processing device according to claim 1 which defines a relative position of a mask, a lens, and a machining object based on this parameter, controls said attenuator according to said relative position, and is characterized by irradiating a machining object with an excimer laser beam of the optimal amount of energy for processing.

It is an attenuator in which attenuation control is possible gradually or without going through stages about an excimer laser beam all over an excimer laser beam way between a laser beam window of a laser generator, and a mask.

A measuring means which measures energy of an excimer laser beam which passed said attenuator.

A transportation device to which at least two of a mask, a lens, and machining objects are moved in parallel with an optical axis.
A control means which controls a detection means to detect a relative position of an image formation face of said mask, a lens, and a mask pattern, said attenuator and a measuring means, a transportation device, and a detection means.

[Claim 3]Maintaining an image formation state of a mask pattern image, while laser radiation is performed to a machining object and processing advances in excimer laser processing by the mask imaging method. [at least two, a mask, a lens, and a machining object,] [by moving in parallel to an optical axis] An excimer-laser-processing method performing material removal of a machining object keeping constant an energy density of an excimer laser beam to which pattern reduction percentage is changed gradually or without going through stages and, which is irradiated on a machining object.
[Claim 4]An excimer-laser-processing method according to claim 3 that reduction projection of the mask pattern is carried out on a machining object in excimer laser processing by the mask imaging method, and shape of a laser emission face is characterized by forming a tapered shape pattern which becomes small to a laser plane of incidence.
[Claim 5][by carrying out reduction projection of the mask pattern on a machining object, and scanning at least one of a machining object, an excimer laser beam, and the masks in excimer laser processing by the mask imaging method] An excimer-laser-processing method according to claim 3 forming a slot where width changes.

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to an excimer-laser-processing device and its processing method.
[0002]
[Description of the Prior Art]F whose excimer laser is noble gas and halogen gas, such as Ar, Kr, and Xe, Electric discharge in gas mixed at a fixed rate oscillates Cl, it is a high-output pulse laser which has a short oscillation wavelength in an ultraviolet region, and many examples of application are industrially put in practical use a semiconductor, electronic-parts-related micro processing, etc. taking advantage of this feature. Application to micro processing of polymeric materials including processing of the detailed dawn of the orifice plate of for example, an ink jet recording head, the through hole of a flexible printed circuit board, or a viahole is as the example of application. [processing of polymeric materials, such as polyimide by excimer

laser, polysulfone, polycarbonate, and polyethylene terephthalate,] Since the thermal melting process by other laser for industrial use, for example, CO_2 laser, and a YAG laser is an ablation process called a photochemical reaction of differing, and there are very few thermal effects, high-definition processing is possible.
[0003]The mask imaging method and the contact mask method are known by the perforating process by such excimer laser, and before long, [the mask imaging method] The mask 3 is irradiated after reflecting the excimer laser beam 6 from the excimer laser oscillator 1 by the reflective mirror 2 which is an optical system, as drawing 7 shows, It is a method which carries out expansion or reduction projection and with which expands or reduces the excimer laser beam 6 which passed the shape (mask pattern) of the opening 3a of the mask 3 with the lens 4, and it is made to irradiate on the machining object 5. As a KONTAKU mask method shows [drawing 8], after reflecting the excimer laser beam 6 from the excimer laser oscillator 1 by the reflective mirror 2, expand or reduce with the lens 4 and the mask 3 is irradiated with it, It is the method of perforating the machining object 5 by the excimer laser beam 6 which passed the opening 3a of the mask 3.
[0004]In the mask imaging method shown by drawing 7 among both the perforating process methods mentioned above, It is what carries out image formation of the mask pattern to the lens 4 being to the surface of the machining object 5 fundamentally, The following relational expression (1) is materialized from the reduction percentage (M) of a mask pattern, the energy density (Ew) of the excimer laser beam in an image formation position, and the energy density (Em) of the excimer laser beam on the 3rd page of a mask.
[0005]
$Ew=M^2Em$ -- (1)
However, the following relational expression (2) and (3) is materialized from the clearance (a) between the mask 3 and the lens 4, the clearance (b) between the lens 4 and the surface of the machining object 5 which is an image formation position, and the focal length (f) of the lens 4.
[0006]
$M=a/b$ -- (2)
$1/a+1/b=1/f$ -- (3)
It is necessary for the energy density (Ew) in said image formation position to find out the energy density (Ew) in an image formation position beforehand, in order to perform a high-definition perforating process since the optimum value has existed in processing by various materials.
[0007]
[Problem to be solved by the invention]Many of examples of processing using excimer laser are perforation and the slot end, and the mask 3 which has a mask pattern of round shape or

rectangular shape is used for this. For example, in order to process it by changing a bore diameter to the machining object 5 in perforation, it is required to exchange for the mask 3 in which the diameters of a mask pattern differ, or to change the reduction percentage (M) of a mask pattern with the lens 4 so that clearly from drawing 7 or drawing 8.

[0008]Therefore, although what is necessary is just to prepare many masks 3 in carrying out the perforating process of the pattern of a size in which the diameters of a mask pattern differ using the mask 3, The metal mask which the mask for excimer laser processes a metal plate, and is produced, Or since the glass mask which formed the pattern with the thin film material which reflects an excimer laser beam on the glass substrates which passes an excimer laser beam is generally used, Considerable days are to be required for any mask to manufacture it elaborately, and also fairly expensive expense has also started the production.

[0009]When changing the size of the pattern for on the other hand carrying out a perforating process by changing the reduction percentage (M) of a mask pattern, so that clearly from the aforementioned (1) formula, The energy density (Ew) of the excimer laser beam in the image formation position of a mask pattern will change, and the optimal processing energy for the candidate for processing is not necessarily acquired. For example, the energy of the excimer laser beam irradiated by the machining object 5 when enlarging reduction percentage (M) and narrowing down a pattern image becomes large, When the machining objects 5 are polymeric materials, the aspect of thermal processing -- sagging arises -- appears in a processing end face, and at least processed goods fall to it.

[0010]In making many holes of a different diameter of a pattern to the one machining object 5, the mask 3 according to the path of the hole which processes it is required, and complicated work is needed for exchange of the mask 3, positioning of the excimer laser beam 6, etc.

[0011]Although JP,H7-185847,A is proposed as art which solves the problem above-mentioned [these] although there is a problem mentioned above in excimer laser processing, Although a variable slit is used and it enables it to narrow down an excimer laser beam to arbitrary sizes in order that the art of this gazette may narrow down the size of an excimer laser beam to arbitrary sizes by a variable slit, It has the fault that the shape of beam of an excimer laser beam will be limited only to rectangular shape.

[0012]On the other hand, when a perforating process is performed by irradiating with an excimer laser beam, to the size of the excimer laser beam plane of incidence of the machining object 5, the size of an excimer laser beam emission face becomes small, and it is known for the section in a hole being automatically processed into tapered shape as a result of perforation. [OPTRONICS(1994) No.7, and p.141 - 147 reference. When the fact of such tapered shape processing performs hole dawn also by this invention persons' experiment to the machining object of the polyimide material which is one of the polymeric materials, According to the energy density of the excimer laser beam irradiated on the machining object,

the taper angle which the taper angle of 6 thru/or 8 times is automatically formed in a processing section, and is formed still more automatically is checked till becoming settled with the material processed and the energy density of the laser with which it irradiates.
[0013]However, in the perforating process to the machining object 5 which consists of polymeric materials, For example, it is made difficult for the section in a hole to carry out a perforating process to shape with a big taper angle of 10 degrees or more, and the art for solving this SUBJECT is proposed by JP,H7-284975,A and JP,H8-25066,A. However. [the case where it is based on JP,H7-284975,A] [the case where two or more laser radiation is needed about one perforation, SUBJECT that control of an excimer laser beam is also difficult occurs, and it is based on JP,H8-25066,A] Since it irradiates with an excimer laser beam, vibrating a prism by a rack and pinion, it has SUBJECT that a device becomes complicated.
[0014][as a method of forming a slot in a machining object by excimer laser processing] As drawing 9 shows, it irradiates with the rectangular excimer laser beam 6 on the machining object 5 via the mask 3 and the lens 4, The method of performing groove formation of a rectangular cross section is generally used by scanning any at least one of the mask 3, the excimer laser beam 6, and the machining objects 5 with constant speed. However, even if it can perform formation of the slot on the definite width in the method of scanning the pattern of a fixed form, formation of the slot where width is changed is impossible.
[0015]Therefore, without exchanging the mask for laser beam machining, [the purpose of this invention] And the thing for which the excimer-laser-processing device it becomes possible to perform the perforating process of sizes arbitrary as irradiation of the excimer laser beam of the optimal energy density for processing being possible to a machining object high-definition is provided, [and by changing the reduction percentage of a mask pattern gradually or without going through stages, while irradiating with excimer laser on a machining object] Like the hole where a section serves as big tapered form, and the slot where width changes, providing a difficult [-shaped]-shaped processing method has processing by the conventional processing method.
[0016]
[Means for solving problem]Reduction projection is carried out through a lens at a machining object, covering with the mask which has a mask pattern of specified shape, after decreasing the excimer laser beam emitted from an excimer laser oscillator to a predetermined amount of energy by an attenuator in the invention concerning Claim 1, In the excimer-laser-processing device which performs removal processing of mask pattern shape and an analogue, [the size of said mask pattern, the focal length of a lens, pattern reduction percentage, or a machining object] [parameters /, such as a size etc. of the pattern by which reduction projection was carried out, / which had been decided beforehand] The relative position of the mask, the lens, and the machining object was defined automatically, and above-mentioned SUBJECT is

solved by controlling said attenuator according to said relative position as a laser beam machining device irradiating a machining object with the excimer laser beam of the optimal amount of energy for processing.

[0017]In the invention concerning Claim 2, an excimer laser beam gradually or without going through stages all over the excimer laser beam way between the laser beam window of a laser generator, and a mask The attenuator in which attenuation control is possible, The measuring means which measures the energy of the excimer laser beam which passed said attenuator, The transportation device to which at least two of a mask, a lens, and machining objects are moved in parallel with an optical axis, A detection means to detect the relative position of the image formation face of said mask, a lens, and a mask pattern, Provide the control means which controls said attenuator, a measuring means, a transportation device, and a detection means, and, [said control means] While obtaining parameters decided beforehand, such as a size etc. of the mask pattern by which reduction projection was carried out, to the reduction percentage or the machining object of the size of said mask pattern, the focal length of a lens, and the mask pattern to need, Based on this parameter, the relative position of a mask, a lens, and a machining object is defined, Said attenuator was controlled according to said relative position, and above-mentioned SUBJECT is solved as the laser beam machining device according to claim 1 irradiating a machining object with the excimer laser beam of the optimal amount of energy for processing.

[0018]In the excimer laser processing according [on the invention concerning Claim 3, and] to the mask imaging method, Maintaining the image formation state of a mask pattern image, while laser radiation is performed to a machining object and processing advances, [at least two, a mask, a lens, and a machining object,] [by moving in parallel to an optical axis] Above-mentioned SUBJECT is solved as the excimer-laser-processing method performing material removal of a machining object, keeping constant the energy density of the excimer laser beam to which pattern reduction percentage is changed gradually or without going through stages and which is irradiated on a machining object.

[0019]In the excimer laser processing according [on the invention concerning Claim 4, and] to the mask imaging method, Reduction projection of the mask pattern was carried out on the machining object, and the shape of a laser emission face has solved above-mentioned SUBJECT to a laser plane of incidence as the excimer-laser-processing method according to claim 3 forming the tapered shape pattern which becomes small.

[0020]In the excimer laser processing according [on the invention concerning Claim 5, and] to the mask imaging method, Above-mentioned SUBJECT is solved as the excimer-laser-processing method according to claim 3 forming the slot where width changes by carrying out reduction projection of the mask pattern on a machining object, and scanning at least one of a machining object, an excimer laser beam, and the masks.

[0021]The excimer-laser-processing device by this invention can set up arbitrary reduction percentage, as long as excimer laser beam way length can fully secure at least two of a mask, a lens, and machining objects by moving in parallel with an optical axis so that more clearly than drawing 1. That is, if even one mask is produced to one shape, it is possible to carry out reduction projection of the mask pattern on a machining object in arbitrary sizes, and to perform the perforating process of arbitrary sizes. However, if the relative position of a mask, a lens, and a machining object tends to be adjusted and it is going to set up arbitrary reduction percentage, since the energy density of the laser in an image formation position serves as a value determined with said relational expression (1), it will not necessarily become the optimal value for a machining object. Then, by attenuating the energy of the beam irradiated by the attenuator on a mask surface, the energy density of the excimer laser beam eventually irradiated by the machining object surface is adjusted, and it becomes possible to consider it as the optimal value for the candidate for processing.

[0022][by moving at least two, a mask, a lens, and a machining object, according to the laser beam machining device by this invention, maintaining the image formation state of a mask pattern during processing] The size of a mask pattern is changed gradually or without going through stages during processing, It is possible to obtain the optimal laser energy for a machining object, and it enables the shape corresponding to the reduction percentage which changes during laser radiation, for example, a section, to form high-definition and simply the hole of tapered form, the slot where width changes, etc.

[0023]

[Mode for carrying out the invention]Hereafter, the excimer-laser-processing device and processing method concerning an embodiment of the invention are explained in detail.

[0024]Embodiment 1 drawing 1 is a figure showing the composition of the excimer-laser-processing device concerning the embodiment of the invention 1. While this excimer-laser-processing device has the lens 4 which is the mask 3 and lens system for the excimer laser oscillator 1, the reflective mirror 2 which is optical systems, and excimer laser cover, [a device] It has the 1st as the excimer laser oscillator 1, the attenuator 7, the beam splitter 8 that is optical systems, a detecting position, and holding mechanism and the 2nd detecting position and maintaining structure 9, the work stage 10, the energy meter 11 as a measuring means, and the computer 12 as a control means. In the excimer-laser-processing device provided with the above-mentioned composition, the excimer laser oscillator 1 is constituted so that the excimer laser beam 6 may be emitted. The attenuator 7 is constituted so that the excimer laser beam 6 emitted from the excimer laser oscillator 1 may be decreased with the beam of a predetermined amount of energy. The reflective mirror 2 is constituted so that the excimer laser beam 6 decreased by the attenuator 7 may be reflected in the machining object 5 direction. The mask 3 is provided with the opening 3a which has a predetermined mask

pattern, and the excimer laser beam 6 reflected by the reflective mirror 2 is passed in the opening 3a of the shape corresponding to a predetermined mask pattern, and it comprises other than opening 3a so that it may cover. The lens 4 is constituted so that reduction projection of the excimer laser beam 6 which passed the mask 3 may be carried out on the machining object 5 on the work stage 10.

[0025]the 1st and 2nd detecting position and maintaining structure 9 -- each -- the mask 3 and the lens 4 -- each being held in the figure Nakaya seal direction which is an optical axis direction of the excimer laser beam 6 between the reflective mirror 2 and the machining object 5, so that parallel translation is possible, and, [each] [the direction] While feeding back the position detection signal of in which position in the optical path of the excimer laser beam 6 the mask 3 and the lens 4 exist to the computer 12. It is constituted so that parallel translation of the mask 3 and the lens 4 can be carried out in the figure Nakaya seal direction with the driving signal from the computer 12, respectively.

[0026]The beam splitter 8 is inserted between the attenuator 7 and the mask 3, and while making a reflective mirror 2-way pass the excimer laser beam 6, it is constituted so that some excimer laser beams 6 may be entered in the energy meter 11. The energy meter 11 is constituted so that the amount of energy of the excimer laser beam from the beam splitter 8 may be measured and the measurement signal may be fed back to the computer 12. While an output is possible, [the control signal for the computer 12 answering the input of the measurement signal from the energy meter 11, and controlling the attenuation of the excimer laser beam 6 to the attenuator 7] The input of the position detection signal from a detecting position and the maintaining structure 9 is answered, and to this detecting position and maintaining structure 9, the driving signal is constituted so that an output is possible. The computer 12 defines the relative position of the mask 3, the lens 4, and the machining object 5 from the input of the position detection signal from a detecting position and the maintaining structure 9, Supervising the measurement signal from the energy meter 11 according to this relative position, by controlling the attenuator 7, it is constituted so that the machining object 7 can be irradiated with the excimer laser beam of the optimal amount of energy for processing.

[0027]The processing method which actually performs hole processing to the machining object 5 on the work stage 10 using the laser beam machining device by this Embodiment 1 provided with such composition is explained. Here, the opening 3a of the mask 3 serves as a circle configuration of the diameter (phim), and a mask pattern becomes a thing corresponding to this. And hole processing of the diameter (phiw) corresponding to this mask pattern shall be carried out to the machining object 5. In this case, if the size of the working pattern of the hole of the machining object 5 sets to M pattern reduction percentage which shows which is reduced to the size of the mask pattern of the mask 3, the following relational expression (4) will be materialized in that pattern reduction percentage (M).

[0028]

M=phim/phiw -- (4)

Therefore, the following relational expression (5) and (6) is materialized by relational expression (1) - (4).

[0029]

a=f (phi m/phi w+1) and b=f (phi w/phi m+1) -- (5)

Em=(phiw^2/phim^2) Ew -- (6)

Here, Em is an energy density of the energy density of the excimer laser beam 6 which passed the attenuator 7, and the excimer laser beam [in / in Ew / the image formation position 5, i.e., a machining object,] 6.

[0030]Therefore, the size of the mask pattern in which the computer 12 was decided beforehand, [energy density / that is needed for processing / the size of a working pattern, the focal length (f) of the lens 4, and / (Ew)] the mask 3 and the lens 4 -- the amount of energy (Em) of the excimer laser beam 6 which passed each position (a), (b), and the attenuator 7 is computable with said relational expression (5) and (6). the computer 12 is based on this computed value -- the 1st and 2nd detecting position and moving mechanisms 9 -- it being alike, respectively and carrying out the control output of the driving signal -- the mask 3 and the lens 4, [each] [a predetermined position] [position and] About the amount of energy on the mask 3, it obtains from the measurement signal from the energy meter 11, and the control output of the control signal is carried out that it can come so that the energy density of the excimer laser beam on the machining object 5 may turn into a predetermined energy density and the attenuation factor of the attenuator 7 may be changed.

[0031]Next, it is possible to change how many pattern reduction percentage (M), or by using the laser beam machining device by this Embodiment 1 describes a general formula below. According to this invention, the following four are raised as conditions which restrain the diameter of perforation, i.e., pattern reduction percentage, (M).

[0032](a) The size (f) of the whole device, i.e., the focal length of the optical-path-length (b) lens 4 of the excimer laser beam 6

(c) It is a change region of the attenuation factor (eta) of the attenuator 7 which determines pattern reduction percentage (M) among the constraint of attenuation factor good domain above-mentioned [of the beam diameter (d) attenuator 7 of an excimer laser beam] (a) - (d). A theory top and this attenuation factor (eta) are 0< eta<1. -- (7)

Although it comes out, it is about 5 to 95% in practice.

[0033]The following relational expression (8) is materialized in the energy density (Ew) of the excimer laser beam in an image formation position, pattern reduction percentage (M), the attenuation factor (eta) of the excimer laser beam by the attenuator 7, and the energy density (Eo) of the excimer laser beam 6 immediately after emitting from the laser generator 1.

[0034]

$Ew=M^2$ and eta-Eo -- (8)

Since an attenuation factor (eta) will be determined here so that an image formation position excimer laser beam energy density (Ew) may become fixed with the value according to the machining object 5 at this Embodiment 1 if it is alpha<eta<beta, The following relational expression (9) is materialized between the change region of the attenuation factor (eta), and the change region of pattern reduction percentage (M).

[0035]

(1/beta) -(Ew/Eo)$<M^2<$ (1/alpha) and (Eo/Ew)

-- (9)

Based on the above relational expression, processing of the polymeric materials by excimer laser explains this Embodiment 1 still in detail taking the case of processing of the most typical polyimide.

[0036]It is checked that the optimal energy densities (Ew) of an excimer laser beam [in / case of polyimide material / as polymeric materials / in the machining object 5 / the processed surface] are 0.7-1.2 (J/cm^2) by experiment. By the conventional machining, processing makes the target working shape the difficult round hole below the diameter 100 (micrometer). For example, when perforating the machining object 5 in the diameter 50 (micrometer), the mask 3 made from a metal in which the round pattern of the diameter 200 (micrometer) was formed is prepared. If the focal length (f) of the lens 4 to be used is set to 100 (mm) when the energy density (Ew) of the excimer laser beam in a work surface sets to 0.9 (J/cm^2) from the aforementioned ranges 0.7-1.2 (J/cm^2), With said relational expression (6), [the energy density (Em) of the excimer laser beam 6 which passed the attenuator 7] As for the distance (a) between mask lenses, the distance (b) between 500 (mm) and a lens image formation position (machining object 5 surface) is set to 125 (mm) from 0.056 (J/cm^2) and said relational expression (5).

[0037]moreover -- if $Eo=0.1J/cm^2$ and 0.05<=eta<=0.95, pattern reduction percentage (M) will be set to 3.08< M<13.4 with said relational expression (9) -- the mask 3 of the diameter 200 (micrometer) -- the diameter of the hole which can perform a perforating process by one sheet is set to 14.9 (micrometer)-64.9 (micrometer). Although hole shape is made into the circle here, even if it is a thing of a regular polygon, lozenge **********, or the becoming shape, it is possible to process an analogue similarly.

[0038]Embodiment 2 by this invention is described to a secondary embodiment with reference to drawing 2 and drawing 3. If the laser beam machining device shown in drawing 1 mentioned above is used, it is able to process the hole of tapered form on the thickness direction of the

machining object 5 by changing pattern reduction percentage (M), maintaining the combined state of a mask pattern also in the middle of processing, the hole, i.e., the section, to which the path becomes small. In this case, the material thickness of the machining object 5 is small enough to the focal length (f) of the lens 4, and if it is a range which can be disregarded, it is possible by grasping beforehand the working rate of the material by excimer laser processing to perform the perforating process of high-definition tapered form simply.

[0039]drawing 2 (a) shows the mask 3, the lens 4, and the machining object 5 -- the mask 3 and the lens 4 -- each -- the 1st and 2nd detecting position and maintaining structure 9 -- it is movable in the figure Nakaya seal direction in be alike, respectively. The material thickness as polyimide which is polymeric materials about the machining object 5 as drawing 2 (b) shows And T (mm), When the phi1(mm) excimer laser beam outgoing radiation side bore diameter is set to phi 2 (mm) for r (mm/sec) and the excimer laser beam incidence side bore diameter (however, phi1>phi2), the working rate of material with said relational expression (5) and (8). Variation speed Reta (/second) of the drift speed Vm of the mask 3 of t-second after (mm/sec), the drift speed VL of the lens 4 (mm/sec), and the attenuation factor eta of the attenuator 7 becomes as shown in the following relational expression (10), (11), and (12). However, in order to simplify explanation here, it has computed considering the rate of change of a bore diameter as fixed. The machining object 5 is fixed among the mask 3, the lens 4, and the machining object 5, and it has composition to which the lens 4 and the mask 3 are moved.

[0040]

=[Vm] (phi1-phi2) andf-r/T- [phim-T^2/P^2-1/phim]

-- (10)

However, P=T-phi 1-r -(phi1-phi2)- t VL=(phi2-phi1) -1-/phim-f-r/T -- (11)

Reta=2andEw/Eo-(phi1-phi2)/$phim^2$andr/T- [(phi1-phi2) - r/T-t-phi 1] -- (12)

Next, the actual example of processing is explained based on each above-mentioned relational expression. For example, suppose that the perforating process of the diameter 60 (micrometer) of a hole entrance and the diameter 15 (micrometer) of a hole exit is performed into polyimide material. 0.9 (J/cm^2), the output energy density 0.1 (J/cm^2) of the laser generator 1, and the focal length (f) of the lens 4 to be used are set to 100 (mm) for the energy density of the excimer laser beam in the diameter 200 (micrometer) of a mask pattern, and a work surface like Embodiment 1. the working rate of material -- 0.04(mm)/-- a second -- material -- thickness -- 0.5 (mm) -- carrying out . Said relational expression (10) By - (12), the drift speed (Vm) of the mask 3, the drift speed (VL) of the lens 4, and the attenuation factor variation speed (Reta) of the attenuator 7 are called for as follows as a function of the elapsed time (t) after starting processing.

[0041]Vm=-0.018 / $(0.03 - 0.0018t)^2$+1.8 (mm/second)

VL=1.8 (mm/second)
Reta= 0.005832t-0.0972 drawing 3 (a) expresses the calculation result about the drift speed (Vm) of the above-mentioned mask 3, the drift speed (VL) of the lens 4, and the attenuation factor variation speed (Reta) of the attenuator 7 to a chart. Since the value of each control parameter in the elapsed time t after starting processing is calculable by computer 12 beforehand based on this chart, Based on the calculated value, the computer 12 should just control the position control of the mask 3 and the lens 4, and the attenuation factor of the attenuator 7 without going through stages. It is common to consider that the value of each parameter is constant and to calculate gradually between minute time intervals (deltat), as drawing 3 (b) shows approximately. in this case, the more it makes deltat small, the more the accuracy of calculation improves -- things -- **
[0042]It is possible to perform only processing of a pattern with a larger hole entrance size by the side of phi1>phi2, i.e., excimer laser beam incidence, than the size of the hole exit by the side of excimer laser beam outgoing radiation depending on this Embodiment 2, so that clearly from the principle.
[0043]Embodiment 3 by embodiment 3 this invention is described with reference to drawing 4 and drawing 5. This Embodiment 3 is a case where groove processing is performed to the machining object 5. drawing 4 (a) shows the mask 3, the lens 4, and the machining object 5 -- the mask 3 and the lens 4 -- each -- the 1st and 2nd detecting position and maintaining structure 9 -- it is movable in the figure Nakaya seal direction in be alike, respectively. The opening 3a of Lxk is formed in the mask 3 of drawing 4 (a) for size, and a mask pattern is determined by this. Groove processing which a flute width changes into the machining object 5 shown in drawing 4 (a) and (b) with this mask pattern L1-L2 is performed. Groove processing from which width changes to the machining object 5 using the excimer-laser-processing device shown by drawing 1 is carried out to the groove processing in this Embodiment 3.
[0044]When it explains below, the oscillating frequency of the excimer laser beam 6 of the excimer laser oscillator 1 H (Hz), In the length of the working pattern in the scan speed v (mm/second) and a scanning direction, when k (mm) and a working rate are set to r (mm/sec) and the tooth depth formed is set to h (mm), the following relational expression (13) is materialized in these Seki.
[0045]
h=k-r-H/v -- (13)
When processing the slot where the depth is constant and width differs, in order to simplify explanation, If the mask pattern length of the direction where a flute width presupposes that it changes at a rate fixed from L1 (mm) to L2 (mm) (however, L1>L2), and intersects perpendicularly with length [of a slot] j (mm) and said k is set to L, From the above-mentioned formula, variation speed Reta (/second) of the drift speed Vm of the mask 3 (mm/second), the

drift speed V1 (mm/second) of the lens 4, and the attenuation factor M of the attenuator 7 is as follows. However, the machining object 5 was fixed among the mask 3, the lens 4, and the machining object 5, and it had composition which the mask 3 and the lens 4 move.
[0046]
Vm=f and 1-/alpha-eand{L/ [L1-L-e] ^{2}-1 / L}
-- (14)
V1=-f.1/L.1-/alpha-e -- (15)
Reta=2, Ew/Eo, and 1/L^2 and 1/alpha-(e-L1+L) -e -- (16)
At this time, the scan speed (Vs) of the work stage 10 is as follows.
[0047]
Vs=r-H/h-k/L- (L1-L-e) -- (17)
However, e=exp [(t+beta) /alpha]
[by substituting for relational expression (14) - (16) the numerical value beforehand decided by alpha=r-H-k-j and 1/(L2-L1) -1/h.1 / L beta=alpha-log$_e$L this embodiment 3 like Embodiment 2]
The drift speed of the mask 3 and the lens 4, the attenuation factor of ATTENEKU 7, and the scan speed (Vs) of the work stage 10 are defined with the function of the time (t) after starting processing. Drawing 5 (a) expresses the aforementioned calculation result to a chart typically.
[0048]Since the value of each control parameter in the elapsed time t after starting processing based on the chart of drawing 5 (a) in this Embodiment 3 like Embodiment 2 is calculable by computer 12 beforehand, What is necessary is just to control the position of the mask 3 and the lens 4, and the attenuation factor M of the attenuator 7 without going through stages based on the calculated value. It is common to calculate gradually by considering that the value of each parameter is constant between Seki gaps (deltat) at the time of minute, as drawing 5 (b) shows approximately. In this case, the more it makes deltat small, the more the accuracy of calculation will improve.
[0049]The art described by JP,H8-88161,A here is explained with reference to drawing 6. Drawing 6 (a) is an excimer-laser-processing device of the gazette, and drawing 6 (b) is an excimer-laser-processing device by an embodiment of the invention. As opposed to outputting the circular excimer laser beam 6 from the excimer laser oscillator 1, condensing the circular excimer laser beam 6 with the lens 4 in the gazette of drawing 6 (a), and carrying out irradiation processing in the focus at the machining object 5, In the embodiment of the invention of drawing 6 (b), the rectangular excimer laser beam 6 is outputted from the excimer laser oscillator 1, and after using the excimer laser beam 6 of the rectangle as a mask pattern with the mask 3, the machining object 5 is irradiated via the lens 4. Therefore, the excimer laser beam 6 outputted from the excimer laser oscillator 1 adjusts the beam diameter by a beam diameter variable means from the beam diameter detected before entering into the lens

4, and, in the case of the gazette, has the composition of detecting the adjusted beam diameter, but. The excimer laser beam 6 with which the machining object 5 is irradiated in an embodiment of the invention is a projection image of a mask pattern, the size of the projection image is uniquely decided by the relative position of the mask 3, the lens 4, and the machining object 5, and a beam diameter variable means like the gazette does not have it. That is, in the case of the gazette, since it is necessary to adjust an excimer laser beam before entering into the lens 4 nearest to the machining object 5, the size of the beam of an excimer laser beam must be controlled by a beam diameter variable means. On the other hand, since it is not necessary to adjust before entering an excimer laser beam into the lens 4 nearest to the machining object 5 in this embodiment, processing of as opposed to [such a beam diameter variable means is unnecessary, can control the size of a beam by projecting magnification of a mask pattern, and] the machining object 5 -- accuracy -- it is to be able to carry out highly

[0050]

[Effect of the Invention]According to the excimer-laser-processing device of this invention, so that more clearly than the above explanation. Reduction projection is carried out through a lens at a machining object, covering with the mask which has a mask pattern of specified shape, after decreasing the excimer laser beam emitted from an excimer laser oscillator to a predetermined amount of energy by an attenuator, In the excimer-laser-processing device which performs removal processing of mask pattern shape and an analogue, [the size of said mask pattern, the focal length of a lens, pattern reduction percentage, or a machining object] [parameters /, such as a size etc. of the pattern by which reduction projection was carried out, / which had been decided beforehand] [irradiate / by defining the relative position of a mask, a lens, and a machining object automatically, and controlling said attenuator according to said relative position / with the excimer laser beam of the optimal amount of energy for processing / a machining object] [at least two of a mask a lens, and machining objects] [by moving in parallel with an optical axis] If even one mask is produced to one shape as a result of being able to set up arbitrary reduction percentage, as long as excimer laser beam way length can fully secure, reduction projection of the mask pattern will be carried out on a machining object in arbitrary sizes, The energy density of the excimer laser beam eventually irradiated by the machining object surface by attenuating the energy of the beam irradiated by the attenuator on a mask surface is adjusted, It becomes possible to perform high-definition processing, without exchanging masks, since it can be considered as the optimal value for the candidate for processing. [by moving at least two, a mask, a lens, and a machining object, according to the laser beam machining device by this invention, maintaining the image formation state of a mask pattern during processing] The size of a mask pattern is changed gradually or without going through stages during processing, It is possible to obtain the optimal laser energy for processing, and it irradiates with laser, While material removal is performed, it

enables the shape acquired while changing pattern reduction percentage, for example, a section, to process high-definition and simply the shape where the hole of tapered form and width change and where it was difficult to process it until now, such as a slot.

[0051]In the excimer laser processing [according to the excimer-laser-processing method of this invention] by the mask imaging method, Maintaining the image formation state of a mask pattern image, while laser radiation is performed to a machining object and processing advances, [at least two, a mask, a lens, and a machining object,] [by moving in parallel to an optical axis] [perform / keeping constant the energy density of the excimer laser beam to which pattern reduction percentage is changed gradually or without going through stages and which is irradiated on a machining object / material removal of a machining object] For example, a section irradiates with excimer laser beams, such as a slot where the hole of tapered form and width change, and the shape acquired while material removal is performed and pattern reduction percentage is changed can be processed.

[Brief Description of the Drawings]

[Drawing 1]The lineblock diagram of the excimer-laser-processing device concerning the embodiment of the invention 1

[Drawing 2]The figure with which explanation of the laser beam machining method of the embodiment of the invention 2 is presented

[Drawing 3]The chart with which explanation of the processing method of drawing 1 is presented.

[Drawing 4]The figure with which explanation of the laser beam machining method of the embodiment of the invention 3 is presented

[Drawing 5]The chart with which explanation of the processing method of drawing 4 is presented.

[Drawing 6]The figure with which explanation of the difference with a Prior art and an embodiment of the invention is presented.

[Drawing 7]The figure with which explanation of the mask imaging method in laser beam machining is presented.

[Drawing 8]The figure with which explanation of the contact mask method in laser beam machining is presented.

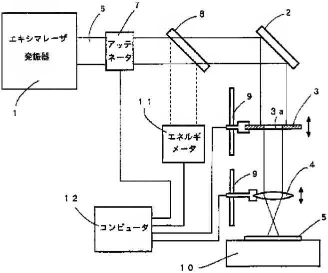
[Drawing 9]The figure with which explanation of the method of forming a slot in a machining object by excimer laser processing is presented.

[Explanations of letters or numerals]

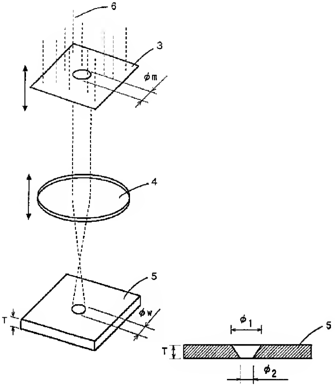
1 Excimer laser oscillator

2 Reflective mirror
3 Mask
4 Lens
5 Machining object
6 Excimer laser beam
7 Attenuator
8 Beam splitter
9 Detecting position and parallel translation mechanism
10 Work stage
11 Energy meter
12 Computer

[Drawing 1]

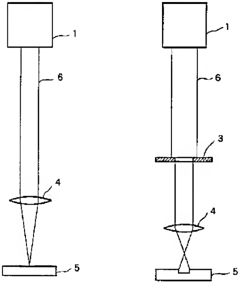


[Drawing 2]



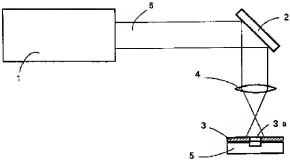
(a) (b)

[Drawing 6]

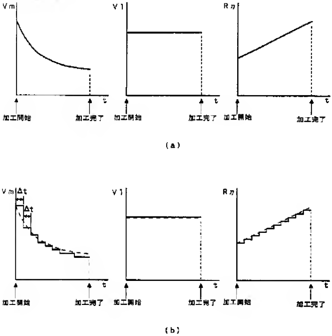


(a) (b)

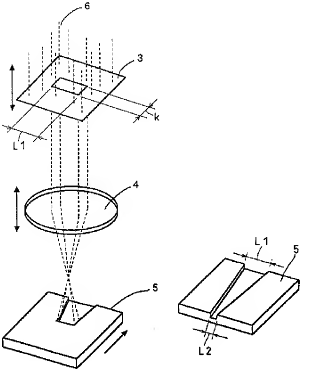
[Drawing 8]



[Drawing 3]

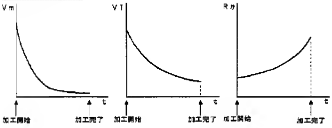


[Drawing 4]

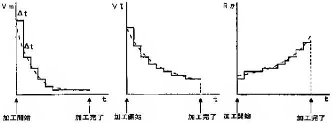


(a) (b)

[Drawing 5]

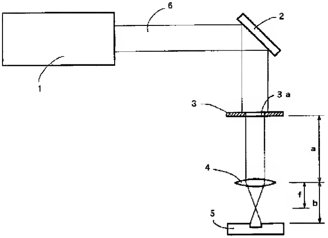


(a)

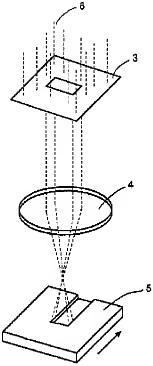


(b)

[Drawing 7]



[Drawing 9]



[Translation done.]